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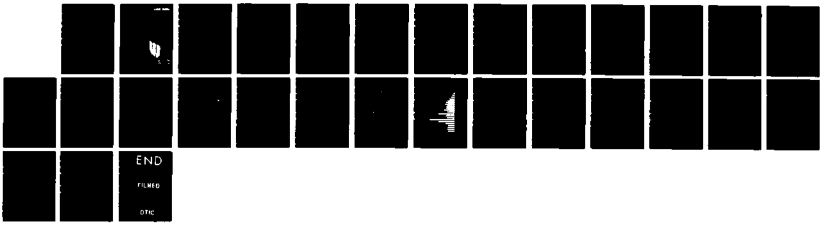

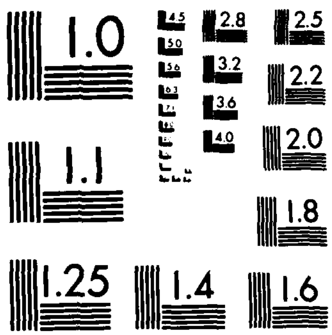

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TECHNICAL REPORT N-85/04
March 1985

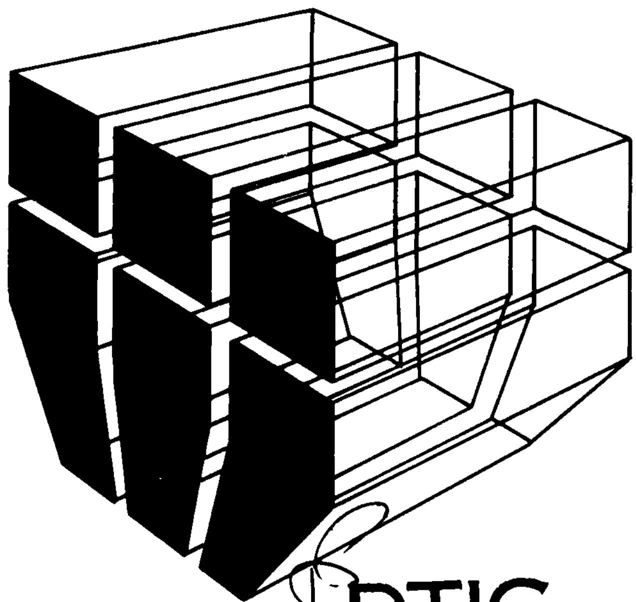
AD-A154 063

OPERATIONAL NOISE DATA FOR THE LACV-30 AIR CUSHION VEHICLE

by
Paul D. Schomer

Operational data for the LACV-30 air cushion vehicle were gathered and developed into sound exposure level vs. distance curves. These data are available for the Army Environmental Hygiene Agency (AEHA) to use in developing noise zone maps for LACV-30 operations in support of the Army Installation Compatible Use Program (ICUZ). ICUZ defines land uses compatible with various noise levels and establishes a policy for achieving such uses.

Although the Army classifies the LACV-30 as an amphibious vehicle, an examination of its noise characteristics and operations showed it most closely resembles a helicopter. Thus the methodology for gathering rotary wing aircraft data was used. Measurements of LACV-30's passby runs over water at various distances and speeds were similar in concept to flyover and flyby measurements for helicopters, and the land maneuver measurements corresponded most nearly to a helicopter's hover measurements.



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Operational data for the LACV-30 air cushion vehicle were gathered and developed into sound exposure level vs. distance curves. These data are available for the Army Environmental Hygiene Agency (AEHA) to use in developing noise zone maps for LACV-30 operations in support of the Army Installation Compatible Use Program (ICUZ). ICUZ defines land use compatible with various noise levels and establishes a policy for achieving such uses.

Although the Army classifies the LACV-30 as an amphibious vehicle, an examination -->

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of its noise characteristics and operations showed it most closely resembles a helicopter. Thus the methodology for gathering rotary wing aircraft data was used. Measurements of LACV-30's passby runs over water at various distances and speeds were similar in concept to flyover and flyby measurements for helicopters, and the land maneuver measurements corresponded most nearly to a helicopter's hover measurements.

FOREWORD

This study was conducted for Fort Belvoir, VA, Research and Development Center (STRB-E-GRD), under IAO-A4105, dated January 1984.

The work was performed by the Environmental Division (EN) of the U.S. Army Construction Engineering Research Laboratory (USA-CERL). Dr. R. K. Jain is Chief of USA-CERL-EN.

COL Paul J. Theuer is Commander and Director of USA-CERL, and Dr. L. R. Shaffer is Technical Director.

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OPERATIONAL NOISE DATA FOR THE LACV-30 AIR CUSHION VEHICLE

1 INTRODUCTION

Background

In recent years, residential development has occurred near military installations areas subject to high noise levels. To ensure that this development does not affect the operating capabilities of those installations, the U.S. Army has instituted the Installation Compatible Use Zone Program (ICUZ).[1] Like the Department of Defense's (DOD) *Construction Criteria Manual* and Air Installation Compatible Use Zone program (AICUZ), the ICUZ program defines land uses compatible with various noise levels and establishes a policy for achieving such uses.[2] The ICUZ program stresses Army-unique noise sources such as blasts (e.g., from artillery, armor, demolition) and rotary-wing aircraft.

Noise zone maps for the ICUZ program are developed by the Army Environmental Hygiene Agency (AEHA) using the U.S. Army Construction Engineering Research Laboratory's (USA-CERL) Integrated Noise Contour System (INCS). This system can produce joint noise zone maps for blast noise and fixed- and rotary-wing aircraft operations. Blast noise zone maps are produced using the USA-CERL-developed BNOISE-3.2 computerized prediction procedure; helicopter noise zone maps are developed using a USA-CERL-modified Air Force NOISE MAP Computer Prediction Program.[3] Each of these computerized prediction methods relies on three separate data sets: (1) source emissions data, (2) data detailing sound propagation from source to receiver, and (3) data defining the human and community response to the received noise.

Previous USA-CERL research has addressed, to some degree, these sets of data for rotary-wing aircraft and for blast noise prediction, but no previous work addressed the noise emissions of the LACV-30 air cushion vehicle, a significant source of noise at some installations.[4] (USA-CERL was asked by Fort Belvoir, VA, Research and Development Center to measure the noise emissions of the LACV-30 in accordance with AR 200-1.[5])

Objective

The objective of this study was to develop sound exposure level (SEL) vs. distance curves for the LACV-30 for use in developing noise zone maps. As a side benefit to this study, some potential reasons for the vehicle's high noise emissions were also determined, and they are presented with suggestions for mitigation.

Approach

Since the LACV-30 is a unique vehicle in the Army, the first step was to determine what methodology to use. The Army has chosen to classify the LACV-30 as a marine vehicle because its use is the amphibious off-loading of materials from ship to shore. However, its operation, construction, and noise source characteristics most closely resemble those of a helicopter or fixed wing aircraft; thus the basic methodology used to characterize rotary wing aircraft noise was chosen. The passby noise emission measurements were made like the flyby measurements of a helicopter. Overland maneuvering noise emissions were characterized like a helicopter's hover operation.

Mode of Technology Transfer

Data developed for LACV-30 SEL vs. distance or speed will be entered in the INCS input data base and will be immediately available for use by AEHA and other DOD installations.

2 TEST OPERATIONS AND DATA COLLECTION METHODS

LACV-30 Operations

The LACV-30 hovers and flies through the air a few centimeters off the surface of water or land. Two types

---

[1] *Installation Compatible Noise Use Zones* (Department of the Army, Office of the Adjutant General, 20 May 1981).

[2] *Construction Criteria Manual*, DOD 4270.1-M (Department of Defense, 1972); *Air Installations Compatible Use Zones*, DOD Instruction 4165-57 (Department of Defense, 1973).

[3] Lincoln L. Little, Violetta I. Pawlowska, and David L. Effland, *Blast Noise Prediction Volume II: BNOISE 3.2 Computer Program Description and Program Listing*, Technical Report N-98/ADA099335 (U.S. Army Construction Engineering Research Laboratory [USA-CERL], 1981); R. D. Horonjeff, R. R. Kandukuri, and N. H. Reddingius, *Community Noise Exposure Resulting From Aircraft Operation: Computer Program Description*, Air Force Report AMRL TR-73-109/ADA004821 (1974).

[4] B. Homans, L. Little, and P. Schomer, *Rotary Wing Aircraft Operational Noise Data*, Technical Report N-38/ADA 051999 (USA-CERL, 1978); P. D. Schomer, Aaron Averbuch, and Richard Raspet, *Operational Noise Data for UH-60A and CH-47C Army Helicopters*, Technical Report N-131/A118796 (USA-CERL, 1982).

[5] AR 200-1, *Environmental Protection and Enhancement* (Headquarters, Department of the Army [HQDA], 15 June 1982), p 7-5.

of operations were performed for this study: overwater passbys and overland maneuvering. The overwater passbys consisted mainly of straight line operation 1/4 nautical mile (nmi)* from shore at various speeds. Several measurements were also taken at 1/8 and 1/2 nmi.

Figures 1 and 2 illustrate the microphone setup for the overwater passbys. The measurements were performed during early January 1984 at Fort Story, VA. Three primary microphones were located on a rocky bluff about 3 m above the sea level, and about 30 m from one another. The LACV-30 followed one of the three paths illustrated in Figures 1 and 2. These paths were respectively 1/8, 1/4, or 1/2 nmi from the primary measurement location and were otherwise parallel to a line tangent to the shoreline at the primary measurement location. Secondary measurements were made inland at locations 4 and 5 in Figure 2.

The overwater test consisted primarily of a set of passbys at the 1/4-nmi distance, with supplemental data at 1/8 and 1/2 nmi. In all passbys, the craft followed the paths indicated in Figure 1, making turns within 1/2 nmi of the edge of the training area. The craft was heavily loaded with a 16-ton container during the test. Operating speeds at 1/4 nmi included typical cruise speed (roughly 40 lb torque), maximum speed (roughly 48 to 50 lb torque), and low, or just below "hump" speed (roughly 33 to 36 lb torque). Below hump is when the craft is plowing through rather than "flying" over the water.

During the passby tests only one craft was operational, so the same craft was used on two consecutive days with two different crews. On the first day, the 1/4-nmi measurements were augmented with one set of typical cruise speed measurements at 1/2 nmi. On the second day, the 1/4-nmi measurements were augmented by typical cruise speed measurements at 1/8 nmi. Table 1 lists the overwater passby operations performed.

Maneuvering measurements were taken as the operator steered the craft through some fairly tight turns in circles and figure eights in sand dunes. Figure 3 illustrates the overland measurement setup and the locations of the five microphones. The craft executed the two maneuvers illustrated in Figure 4, around the two dunes shown in Figure 3. In essence, A-weighted equivalent level (LEQ) at a known distance was developed from the maneuvering craft, and because of the measurement procedures, the equivalent spectrum was available from the tape recordings. Table 2 lists the overland maneuvers.

*One nautical mile = 1828 m.

Measurement Instrumentation

The same measurement instrumentation was used at all locations (positions 1 through 5 at the overwater site and positions 1 through 5 at the overland maneuvering site). Each station consisted of a B&K 4921 1/2-inch quartz coated outdoor microphone system. The microphone signal went to the USA-CERL-developed true-integrating environmental noise monitor and sound exposure level meter and to a Nagra DJ tape recorder.

Figure 5 illustrates the typical station setup. The only difference between sites was that the overwater passby remote sites (stations 4 and 5) used 12-V storage batteries for power while all the other stations were powered from the mobile acoustics van, connected to a 110-V generator or 110-V commercial power.

Meteorological data were gathered using the USA-CERL tethered helium balloon system, a commercially made meteorological sensor which measures wind speed, wind direction, temperature, and humidity at various altitudes. The altitudes for this set of measurements ranged from about 3 to 45 m above the ground.

3 DATA REDUCTION AND RESULTS

The acoustical data were reduced similar to the way SEL vs. distance curves are calculated for flybys of rotary-wing aircraft and similar to how the LEQ vs. distance is calculated for a hovering rotary-wing aircraft.

Passby Data

The passby data were reduced by microphone location and operation to standard day (15°C and 70% relative humidity) SEL vs. distance curves. The basic data consisted of the field measured A-weighted SEL at a site for a passby, and the tape-recorded data. The tape-recorded data were used to develop the time at which the 32-second true Root-Mean-Square (RMS) maximum A-weighted value occurred and from this to determine the 1/3-octave spectrum during that 32-second period. The 32-second time period (in

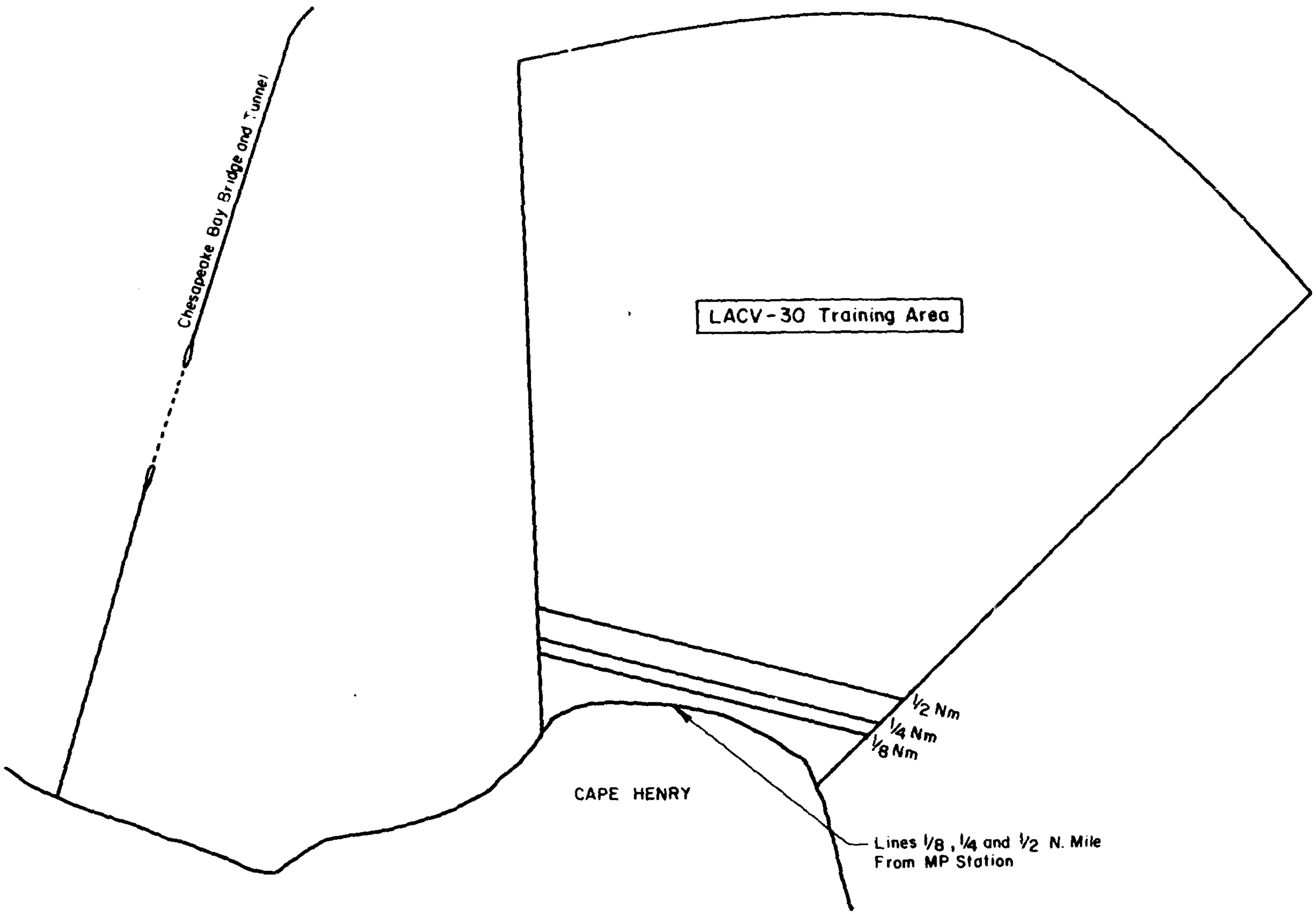

Figure 1. General site layout for LACV-30 noise measurements. The craft followed the lines indicated and made its turns within 1/2 nmi of the training area edge.

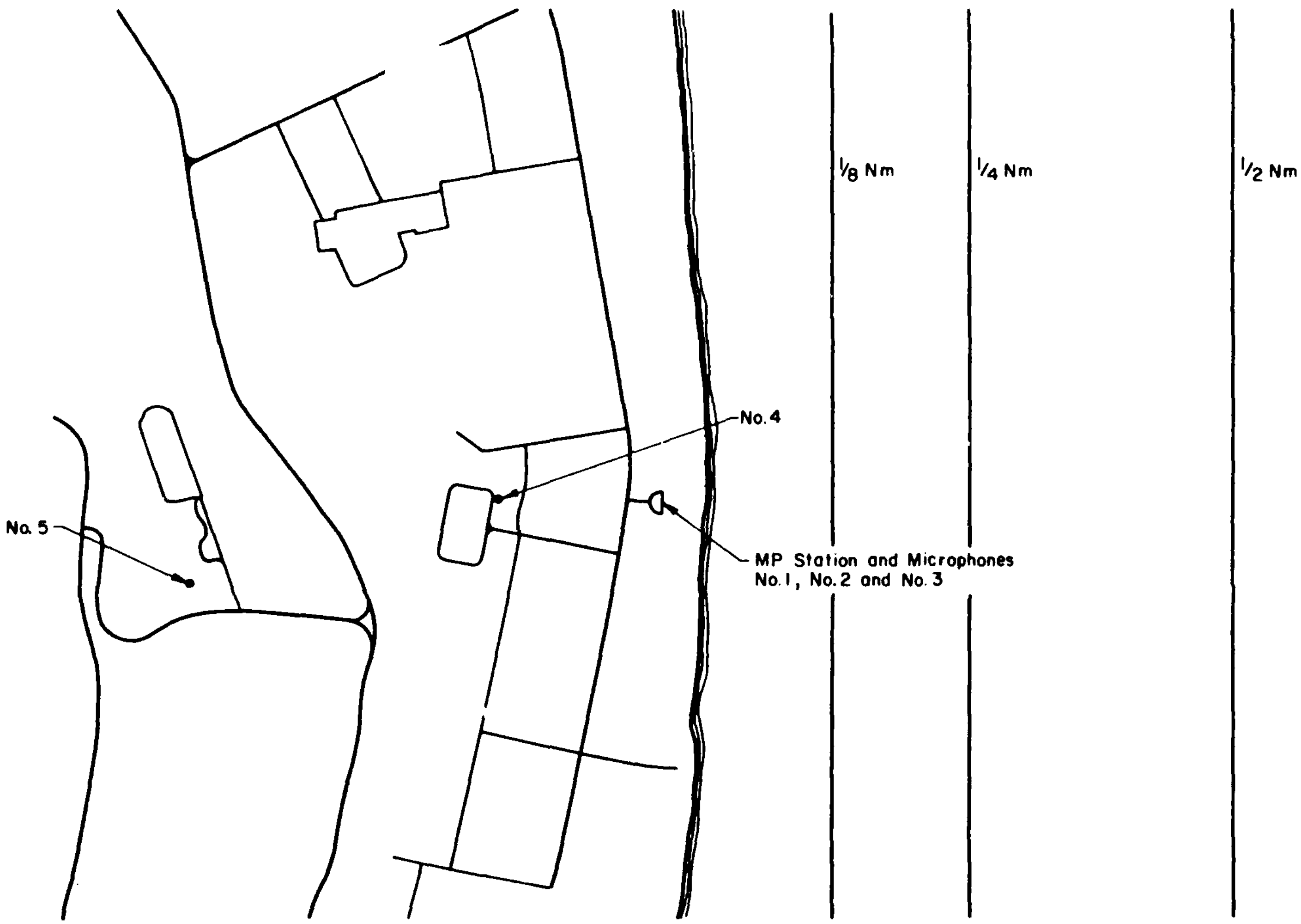

Figure 2. Passby paths and microphone locations.

Table A17

SEL vs. Distance, Set 2, 1/4 nmi at Below Hump Speed, Traveling East and West, Jan 6

Total number averaged: 9
Average distance: 457.20 m
Average relative humidity: 74.60 percent
Average temperature: 14.50 °C
Average max. sound level: 90.40 dB
Average ASEL: 111.39 dB

Distance (m)	Average ASEL (dB)
50	122.0
100	118.9
200	115.6
500	110.9
1000	106.7
2000	101.5
5000	91.9
10000	82.3

Table A18

SEL vs. Distance, 1/4 nmi at Below Hump Speed, Traveling East and West, Jan 5, 6

Total number averaged: 21
Average distance: 457.20 m
Average relative humidity: 85.06 percent
Average temperature: 13.19°C
Average max. sound level: 93.68 dB
Average ASEL: 114.07 dB

Distance (m)	Average ASEL (dB)
50	124.8
100	121.6
200	118.3
500	113.5
1000	109.2
2000	103.9
5000	94.2
10000	84.9

Table A13

SEL vs. Distance, Set 1, 1/4 nmi at High Speed, Traveling East and West, Jan 5

Total number averaged: 12
Average distance: 457.20 m
Average relative humidity: 93.70 percent
Average temperature: 11.60°C
Average max. sound level: 94.40 dB
Average ASEL: 111.23 dB

Distance (m)	Average ASEL (dB)
50	122.1
100	118.9
200	115.5
500	110.6
1000	106.1
2000	100.8
5000	92.1
10000	85.4

Table A14

SEL vs. Distance, Set 2, 1/4 nmi at High Speed, Traveling East and West, Jan 6

Total number averaged: 12
Average distance: 457.20 m
Average relative humidity: 77.30 percent
Average temperature: 13.80°C
Average max. sound level: 87.51 dB
Average ASEL: 103.88 dB

Distance (m)	Average ASEL (dB)
50	114.5
100	111.4
200	108.1
500	103.3
1000	99.2
2000	94.2
5000	85.8
10000	78.5

Table A15

SEL vs. Distance, Over 1/4 nmi at High Speed, Traveling East and West, Jan 5, 6

Total number averaged: 24
Average distance: 457.20 m
Average relative humidity: 85.50 percent
Average temperature: 12.70°C
Average max. sound level: 90.95 dB
Average ASEL: 107.55 dB

Distance (m)	Average ASEL (dB)
50	118.3
100	115.1
200	111.8
500	107.0
1000	102.7
2000	97.5
5000	89.0
10000	82.0

Table A16

SEL vs. Distance, Set 1, 1/4 nmi at Below Hump Speed, Traveling East and West, Jan 5

Total number averaged: 12
Average distance: 457.20 m
Average relative humidity: 92.90 percent
Average temperature: 12.20°C
Average max. sound level: 96.14 dB
Average ASEL: 116.08 dB

Distance (m)	Average ASEL (dB)
50	126.8
100	123.6
200	120.3
500	115.5
1000	111.1
2000	105.7
5000	96.0
10000	86.7

Table A9

SEL vs. Distance, Cruise Speed, Traveling East, for All Distances, Jan 5, 6

Total number averaged: 21
Average distance: 556.47 m
Average relative humidity: 85.66 percent
Average temperature: 12.95°C
Average max. sound level: 93.61 dB
Average ASEL: 109.88 dB

Distance (m)	Average ASEL (dB)
50	122.7
100	118.7
200	115.0
500	110.0
1000	105.6
2000	100.1
5000	90.6
10000	82.0

Table A10

SEL vs. Distance, Cruise Speed, Traveling West, for All Distances, Jan 5, 6

Total number averaged: 24
Average distance: 516.63 m
Average relative humidity: 84.62 percent
Average temperature: 13.06°C
Average max. sound level: 91.48 dB
Average ASEL: 110.36 dB

Distance (m)	Average ASEL (dB)
50	123.1
100	118.8
200	114.8
500	110.0
1000	105.7
2000	100.6
5000	92.0
10000	84.8

Table A11

SEL vs. Distance, Cruise Speed, Jan 5, 6, Traveling East and West, for All Distances

Total number averaged: 45
Average distance: 535.22
Average relative humidity: 85.10 percent
Average temperature: 13.01°C
Average max. sound level: 92.47 dB
Average ASEL: 110.13 dB

Distance (m)	Average ASEL (dB)
50	122.9
100	118.8
200	114.9
500	110.0
1000	105.7
2000	100.4
5000	91.4
10000	83.5

Table A12

SEL vs. Distance for 1/8 and 1/4 nmi at Cruise Speed, Traveling East and West, Jan 5, 6

Total number averaged: 33
Average distance: 397.34 m
Average relative humidity: 81.98 percent
Average temperature: 13.52°C
Average max. sound level: 92.46 dB
Average ASEL: 109.78 dB

Distance (m)	Average ASEL (dB)
50	119.6
100	116.4
200	113.1
500	108.3
1000	104.0
2000	98.8
5000	89.8
10000	82.1

Table A5

SEL vs. Distance, Set 1, Averaged Over 1/4 nmi at Cruise Speed, Jan 5, 6, Traveling East and West

Total number averaged: 12
Average distance: 457.20 m
Average relative humidity: 92.87 percent
Average temperature: 12.33°C
Average max. sound level: 94.95 dB
Average ASEL: 111.48 dB

Distance (m)	Average ASEL (dB)
50	122.4
100	119.2
200	115.8
500	110.8
1000	106.4
2000	101.1
5000	92.0
10000	84.3

Table A6

SEL vs. Distance, Set 2, Averaged Over 1/4 nmi at Cruise Speed, Jan 6, Traveling East and West

Total number averaged: 12
Average distance: 457.20 m
Average relative humidity: 74.60 percent
Average temperature: 14.50°C
Average max. sound level: 89.27 dB
Average ASEL: 108.14 dB

Distance (m)	Average ASEL (dB)
50	118.8
100	115.6
200	112.4
500	107.6
1000	103.5
2000	98.4
5000	89.5
10000	81.5

Table A7

SEL vs. Distance, Set 1, at Cruise Speed, for All Distances, Jan 5, Traveling East and West

Total number averaged: 24
Average distance: 685.80 m
Average relative humidity: 93.28 percent
Average temperature: 11.97°C
Average max. sound level: 93.72 dB
Average ASEL: 111.30 dB

Distance (m)	Average ASEL (dB)
50	127.2
100	122.2
200	117.8
500	112.8
1000	108.3
2000	103.0
5000	93.8
10000	85.9

Table A8

SEL vs. Distance, Set 2, at Cruise Speed, for All Distances, Jan 6, Traveling East and West

Total number averaged: 21
Average distance: 363.13 m
Average relative humidity: 75.76 percent
Average temperature: 14.20°C
Average max. sound level: 91.04 dB
Average ASEL: 108.80 dB

Distance (m)	Average ASEL (dB)
50	118.0
100	114.9
200	111.6
500	106.8
1000	102.6
2000	97.4
5000	88.6
10000	80.8

APPENDIX:

SEL VS. DISTANCE TABLES FOR MICROPHONES 1, 2, AND 3 AVERAGED OVER VARIOUS TYPES OF OPERATIONS

Table A1

Key to Appendix Tables

Table	Date	Speed	Distance	Direction
A2	Both	R	1/4	Both
A3	Both (5 Jan)*	R	1/2	Both
A4	Both (6 Jan)*	R	1/8	Both
A5	5 Jan	R	1/4	Both
A6	6 Jan	R	1/4	Both
A7	5 Jan	R	All	Both
A8	6 Jan	R	All	Both
A9	Both	R	All	E
A10	Both	R	All	W
A11	Both	R	All	Both
A12	Both	R	1/8 and 1/4	Both
A13	5 Jan	H	1/4	Both
A14	6 Jan	H	1/4	Both
A15	Both	H	1/4	Both
A16	5 Jan	L	1/4	Both
A17	6 Jan	L	1/4	Both
A18	Both	L	1/4	Both

Table A2

SEL vs. Distance Averaged Over 1/4 nmi at Cruise Speed, Jan 5, 6, Traveling East and West

Total number averaged: 24
Average distance: 457.20 m
Average relative humidity: 83.73 percent
Average temperature: 13.42°C
Average max. sound level: 92.11 dB
Average ASEL: 109.81 dB

Distance (m)	Average ASEL (dB)
50	120.6
100	117.4
200	114.1
500	109.2
1000	104.9
2000	99.7
5000	90.8
10000	82.9

Table A3

SEL vs. Distance Averaged Over 1/2 nmi at Cruise Speed, Jan 5, 6, Traveling East and West

Total number averaged: 12
Average distance: 914.40 m
Average relative humidity: 93.70 percent
Average temperature: 11.60°C
Average max. sound level: 92.50 dB
Average ASEL: 111.12 dB

Distance (m)	Average ASEL (dB)
50	132.0
100	125.2
200	119.7
500	114.7
1000	110.3
2000	104.9
5000	95.6
10000	87.5

Table A4

SEL vs. Distance Averaged Over 1/8 nmi at Cruise Speed, Jan 5, 6, Traveling East and West

Total number averaged: 9
Average distance: 237.70 m
Average relative humidity: 77.30 percent
Average temperature: 13.80°C
Average max. sound level: 93.41 dB
Average ASEL: 109.68 dB

Distance (m)	Average ASEL (dB)
50	117.0
100	113.8
200	110.5
500	105.7
1000	101.4
2000	96.2
5000	87.3
10000	79.8

Table 3

LACV-30 Operational Noise Level vs. Distance Data

Distance (m)	Cruise Speed, High Speed,* SEL (dB)	Below Hump Speed* SEL (dB)	Maneuver Equivalent Level (dB)
50	122.9	124.8	93.5
100	118.8	121.6	87.3
200	114.9	118.3	80.8
500	110.0	113.5	71.8
1000	105.7	109.2	64.3
2000	100.4	103.9	56.1
5000	91.4	94.2	44.7
10000	83.5	84.9	36.2

*In general, just the cruise speed data should be sufficient for all operations. In certain instances, one may need to separately use the below hump speed data.

passby measurements, levels varied by as much as 10 dB from one day to the next because of sound propagation conditions.

Potential noise mitigation methods include the following:

1. The prop noise can be reduced (probably 10 to 20 dB) by a redesigned prop and possible inclusion of a shroud. Since machinery noise is generally a sign of inefficiency, a quieter prop would likely be more fuel efficient.

2. The relation between operator technique and noise should be constantly stressed. An "overly enthusiastic" type of operation creates more noise and is less efficient; this type of operation should be discouraged. Similar problems (along with comparable reductions in efficiency) are common with helicopters and construction equipment. The solution is stress on the importance of efficient, ***neighborly*** operation of the craft.

3. Since weather conditions play ***the major role*** in sound propagation and the resulting loudness in the community, weather and sound monitoring may be used to adjust operations. For example, time-of-day requirements can be pegged to measured conditions and time of year.

5 CONCLUSION

The report gives the sound exposure level vs. distance curves for the LACV-30 for various speeds and operations over water and over land. These data supplement earlier rotary wing aircraft data developed by USA-CERL and used in the USA-CERL modified version of the Air Force NOISEMAP Prediction Program.

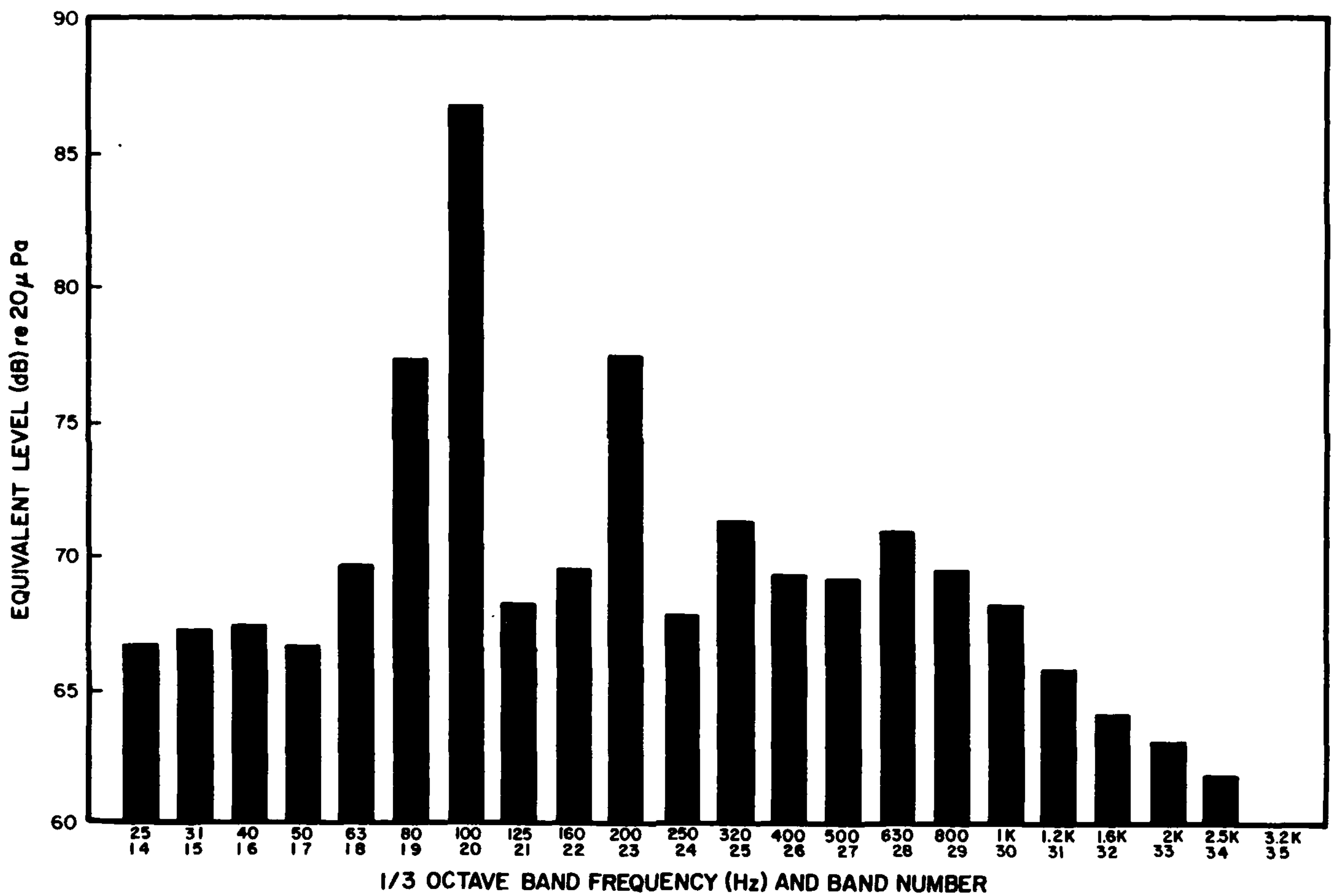

Figure 8. The 1/3-octave spectra of a maneuvering craft at a distance of 275 m.

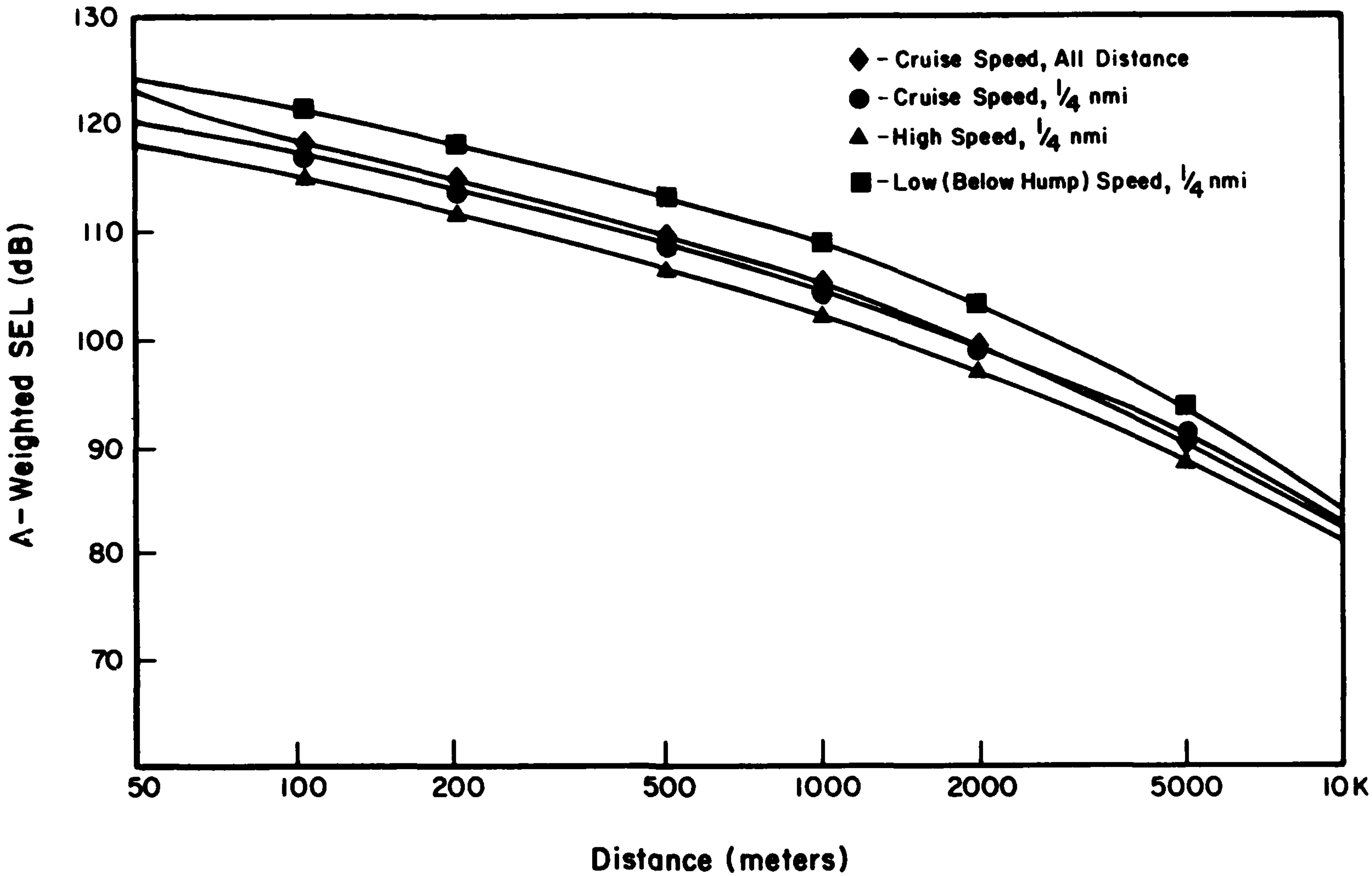

Figure 7. SEL vs. distance, for cruise, high, and below hump speeds.

Inland Measurements

Measurements were also made at locations 4 and 5 inland. Location 4 was about 300 m inland and at roughly the same elevation as microphones 1, 2, and 3 while location 5 was 800 m inland atop a 15 m hill. Comparing the measured SEL at the inland microphones with the corresponding composite prediction curves based on data gathered with the shoreline microphones showed the general trend (as expected) of excess attenuation due to propagation over ground, in addition to normal geometric spreading. This excess attenuation varied between 0 and 16 dB. About 8 or 9 dB was a typical value at station 4. For station 5, on a hill top, the results were quite mixed. In one instance for below hump speed operation, the hilltop measurements actually exceeded the value predicted by the shoreline microphones by about 3 1/2 dB. Since this location was on a 15-m hill, refraction out of a shadow zone may have contributed to high levels, with ground reflection less of a factor.

For predictions of overland passby noise levels, it is recommended that 8 dB be subtracted from the overwater SEL vs. distance prediction when the land site is substantially inland and the elevation is near sea level. When the land site has elevated terrain or the receiver is at a high location, then diffraction is more important than excess ground attenuation and nothing should be subtracted from the overwater SEL vs. distance curves.

Different Speeds

Comparisons were also made as a function of speed. In addition to the normal cruise speed, data were gathered for high and below hump speed. Figure 7 compares these three composite data sets. The below hump speed creates a slightly higher SEL than does the cruise speed. The high speed SELs are slightly lower than the cruise speed SELs. In general, overwater LACV-30 operations can probably be adequately represented by the cruise speed composite curve, but in critical instances one may wish to use the below hump composite for this mode of operation.

Overland Maneuver Data

The overland maneuver data were analyzed by finding the equivalent 1/3-octave spectrum levels for the entire maneuver. Because microphone 5 was on a hill and closer to the center of the array than microphones 1 through 4, 3.1 dB were subtracted from microphone 5's spectrum to make it equivalent (in terms of distance) to the other four spectra. The 3.1-dB figure was calculated as 20 log 275/192 since the hill position was 192 m from the center while the other microphones were 275 m from the center. The resulting 1/3-octave spectra were also corrected for an additional 85 m of atmospheric absorption (temperature and relative humidity did not change much during the 1 day these data were gathered). These 1/3-octave spectra were similar from operation to operation and were averaged (on an energy basis) over all the operations performed to form an overall measured equivalent 1/3-octave spectrum at a distance of 275 m from the center of a maneuvering area for a maneuvering craft. This 1/3-octave spectrum (Figure 7) was converted to an A-weighted LEQ vs. distance using the methods of ANSI S1.26-1978 to vary the 1/3-octave levels in terms of atmospheric attenuation (correcting to 15°C and 70 percent relative humidity) with distance and a factor of 20 log D/D_m to vary the overall level with distance.

Table 3 contains the overall results. The second column is the A-weighted SEL vs. distance (where distance is point of closest approach) for a craft traveling at cruise speed or high speed on the water, the third column contains the below hump speed SEL data, and the fourth column contains the equivalent A-weighted level vs. distance (from the geometric center of the maneuver area) for a craft maneuvering on land. These data have been entered into the data base of the INCS and are available for the development of noise zone maps by AEHA and others.

4 NOISE SOURCES AND POTENTIAL MITIGATION METHODS

Several reasons for high noise emissions from the LACV-30 were identified during the course of data gathering and are included here as useful information.

The measured passby levels of approximately 110 dB (A-weighted SEL) at 1/4 and 1/2 nmi indicate this is a very noisy craft. The spectra (Figure 8) show that the primary noise source is at 100 Hz, which is the blade passage frequency of the props.

Operator technique is also a factor in the noise generated by the LACV-30, at least over land. During the maneuver tests, the second operator moved the craft more quickly but with less control than did the first, taking longer to perform the maneuver and creating higher noise peaks.

Weather conditions play a major role in the noise which propagates from the LACV-30. During the

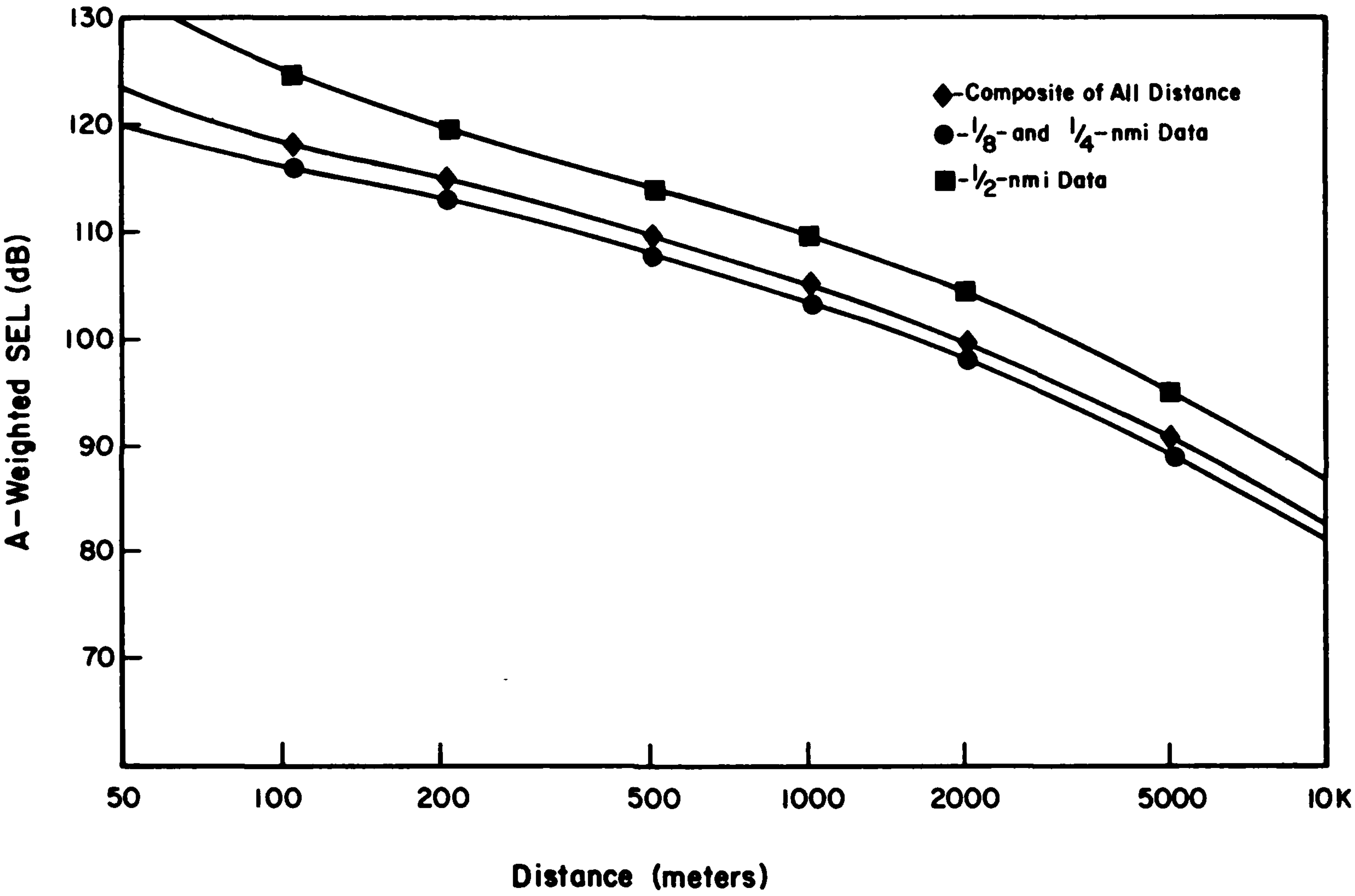

Figure 6. SEL vs. distance for cruise speed.

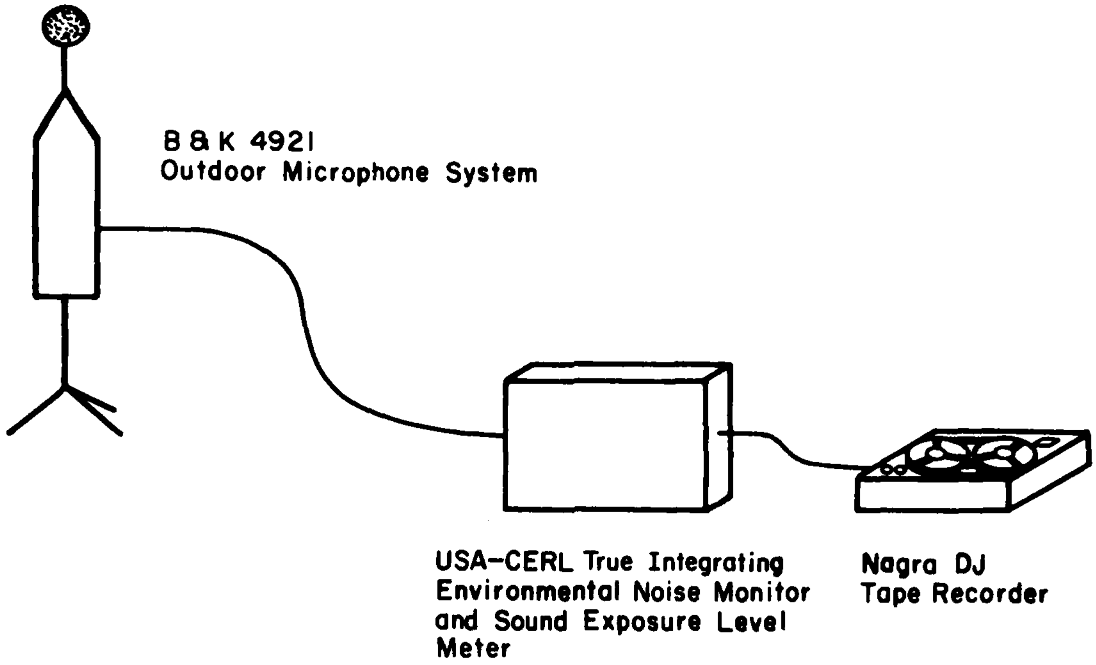

Figure 5. Measurement equipment at a site.

contrast to 2 seconds for aircraft) was used because of the LACV-30's slow speed and long passby time compared to aircraft speed.* Each measured SEL and 1/3 octave spectrum was then developed into an SEL vs. distance curve using three factors. These factors were the 1/3-octave band absorption values in ANSI S1.26-1978,[6] the factor for the spherical spreading of sound (20 log D/D_m where D is the distance in question and D_m is the measurement distance), and the factor 10 log (D_m/D) to account for the duration change in SEL with distance.

Shoreline Measurements

The various site and distance data were arrayed for a given operation, such as normal power cruise. As indicated above, primary use was made of data gathered by the three shoreline microphones and the 1/4 nmi passbys. The data were gathered on two consecutive days. Sound propagation from ship to shore was much stronger on the first day than the second, resulting in higher sound levels recorded on the first day. On the first day, readings were also taken 1/2 nmi from shore and on the second day 1/8 nmi from shore.

Except for the measurements made at 1/2 nmi the first day, the general results were fairly consistent from one distance and day to the next. On the first day, however, sound propagation conditions were such that the measurements made at 1/2 nmi were virtually identical to the results at 1/4 nmi; there was no change with distance.

The appendix tabulates various SEL vs. distance combinations calculated. Figure 6 illustrates the composite SEL vs. distance for 1/4 and 1/8 nmi, calculated using microphones 1, 2, and 3, during cruise speed on the first and second day. Figure 6 also shows just the 1/2-nmi data and a composite of all the cruise speed data. The 1/2-nmi data raise the composite average by 2 to 3 dB over what it would otherwise be. These data were included since they were valid.

*The data were also analyzed using a 1/2-second time period. Using this very short time only resulted in changes of a few tenths of a decibel in the SEL vs. distance curves (Appendix).

[6]American National Standard Institute (ANSI) Standard S1.26-1978, "Method for the Calculation of Absorption of Sound by the Atmosphere."

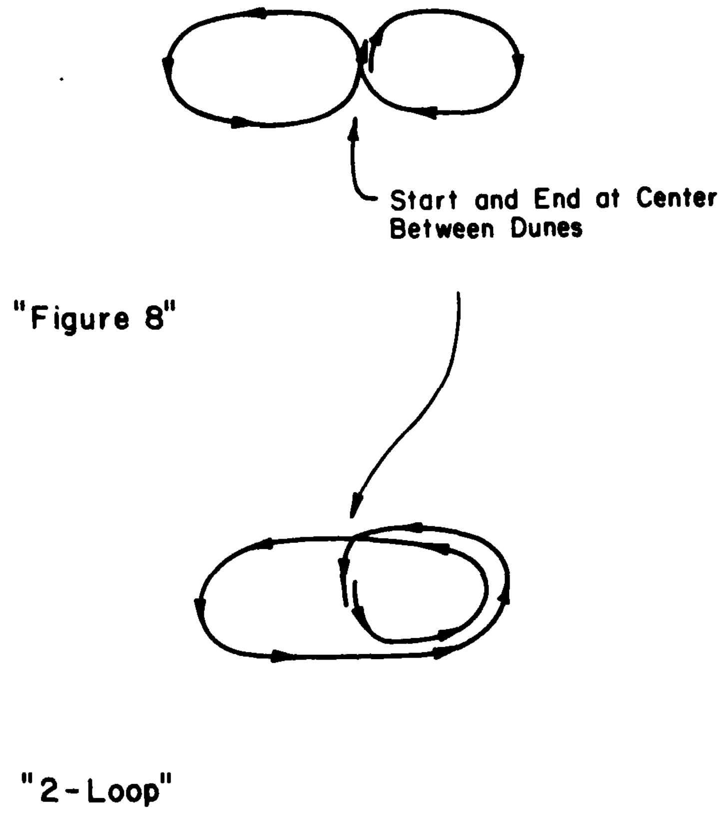

Figure 4. Land maneuver patterns for the LACV-30

Table 2

Overland Maneuvers

Run No.*	Set No.	Maneuver**
33	3	"Fig. 8"
34	3	"Fig. 8"
35	3	2-loop
36	3	2-loop
37	4	2-loop
38	4	2-loop
39	4	"Fig. 8"

*A typical land maneuver took 15-20 minutes
**See Figures 3 and 4 for definition of land maneuvers

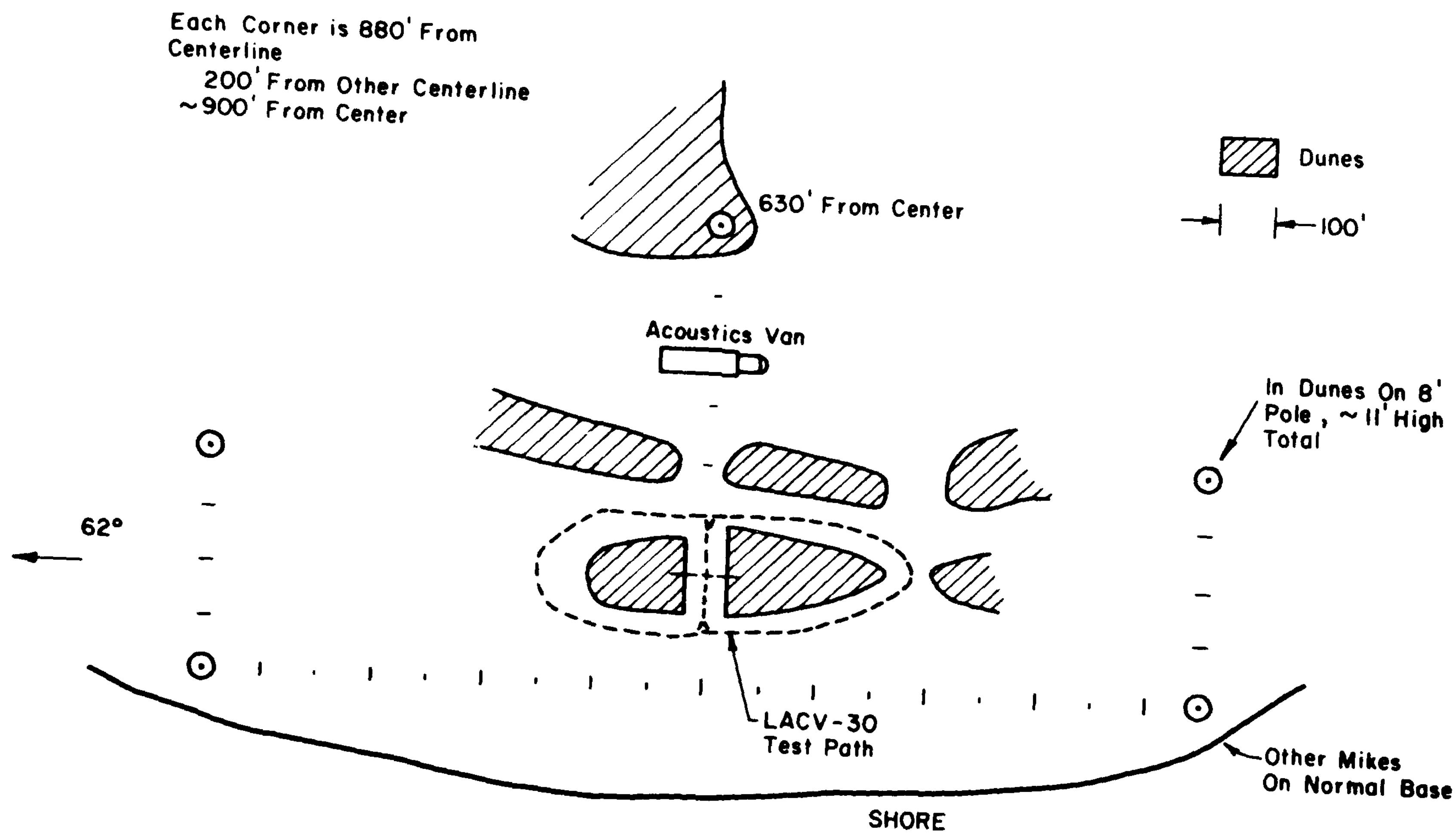

Figure 3. Test site layout for land maneuver measurements of the LACV-30.

Table 1

Overwater Passby Operations

a. Set 1, MP Station, 5 Jan 84

Run No.	Direction	Distance (nmi)	Speed*
1	W	1/4	R
2	E	1/4	R
3	W	1/4	R
4	E	1/4	R
5	E	1/4	L
6	W	1/4	L
7	E	1/4	L
8	W	1/4	L
9	E	1/4	H
10	W	1/4	H
11	E	1/4	H
12	W	1/4	H
13	E	1/2	R
14	W	1/2	R
15	E	1/2	R
16	W	1/2	R

b. Set 2, MP Station, 6 Jan 84

Run No.	Direction	Distance (nmi)	Speed*
17	E	1/4	R
18	W	1/4	R
19	E	1/4	R
20	W	1/4	R
21	E	1/4	L
22	W	1/4	L
23	E	1/4	L
24	W	1/4	L
25	E	1/4	H
26	Aborted	–	–
27	E	1/4	H
28	W	1/4	H
29	E	1/4	H
30	W	1/8	R
31	E	1/8	R
32	W	1/8	R

*R = cruise speed
L = below hump speed
H = high speed

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